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Managing Water in the West

Technical Report for Arrowrock Dam Biological Opinion #1009.0405 OALS #00-912

Trap and Transport of Bull Trout From Lucky Peak Reservoir to Arrowrock Reservoir, Idaho

Summary Report for Years 2000 - 2004

U.S. Department of the Interior
Bureau of Reclamation

September 2004

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Summary report for years 2000 through 2004

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TRAP AND TRANSPORT OF BULL TROUT (*Salvelinus confluentus*) FROM LUCKY PEAK RESERVOIR TO ARROWROCK RESERVOIR, IDAHO

Abstract

Bull trout (*Salvelinus confluentus)* were captured in Lucky Peak Reservoir using three methods and transported above Arrowrock Dam for release into Arrowrock Reservoir. Trapping occurred between the months of April through June in years 2000 through 2004. A total of 86 bull trout were captured ranging from 255 mm to 660 mm in total length and 198 g to 5402 g in weight. Capture rates appeared to be related to air and surface water temperature and reservoir volume. Bull trout that were captured and released into Arrowrock reservoir were documented to migrate into main-stem rivers during the summer and fall months. Catch rates for bull trout declined over the first three years, but increased in 2004. Gillnetting was the most effective method for capturing bull trout. Recommendations for future operations include using in proximity to the spilling basin with twenty-minute sets. Sampling time frames must encompass the period of mid-May to mid-June to maximize the probability of catching bull trout.

Introduction

Since the listing of the Columbia River and Klamath River distinct population segment of bull trout (*Salvelinus confluentus*) as threatened under the Endangered Species Act in 1998, serious consideration has been given to range-wide population size and recovery efforts. Section 7 of the Endangered Species Act requires that any actions that may be implemented by the federal government entity that could affect federally listed species must be consulted upon through the federal regulatory agencies: the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service. The U.S. Bureau of Reclamation consulted upon its water operations in the Upper Snake River in 1999 (Reclamation 1998). Reclamation was issued a Biological Opinion from the FWS in 1999 with numerous mandates, including terms and conditions that address entrainment of bull trout at facilities where bull trout occur. Arrowrock Dam was identified as one project with significant rates of entrainment that would require reduction and mitigation until an appropriate level of entrainment was reached (FWS 1999). This report describes the results of Reclamation's mitigation work, trapping entrained bull trout and returning them to Arrowrock Reservoir.

The Boise River basin is a highly regulated river system, with three reservoirs and numerous irrigation diversions. These water projects were constructed primarily for the purpose of providing irrigation water, hydroelectricity, and flood control, but they are also important recreation areas and provide fish and wildlife habitat. The subpopulations of bull trout in the Boise River basin form one of the southern-most distributions in the Columbia River basin (Rieman et al. 1997). Although the Boise River basin is divided into segments by several dams, the sub-basins upstream from Arrowrock and Anderson Ranch reservoirs provide substantial habitat for bull trout and bull trout presence and migration have been recorded throughout the watersheds (Rieman and McIntyre 1995, IDFG unpublished data 1998, Flatter 1998, Salow 2001).

1. Arrowrock Dam was constructed in 1915 by the U. S. Bureau of Reclamation (Reclamation) as part of the Boise Projects. The valve outlet works of the facility have exceeded the age for which they were designed and were replaced in 2003 (Reclamation 2001). The valve replacement work was initiated in 2001 and required a near complete evacuation of the reservoir volume from September 2003 through February 2004 to complete construction. Reclamation has completed a Final Environmental Impact Statement and Biological Assessment for the impacts of the valve replacement project to comply with the National Environmental Policy Act and the Endangered Species Act respectively (Reclamation 2001).

The purpose of this report is to summarize the trap and transport project (Conditions outlined in both Biological Opinions for the facility) that was initiated in year 2000 and continued each spring season through 2004.

Study Area

The Boise River basin is located in southwestern Idaho and is a major tributary to the Snake River. Three dams are constructed on the upper Boise River system: Arrowrock, Anderson Ranch, and Lucky Peak dams. Lucky Peak Dam, an Army Corps

of Engineers project, is the lowest elevation of the three projects and is located at Boise river kilometer (rkm) 103 with a full pool elevation of 931 meters above mean sea level (msl) and a 3.26 x 10^5 km^3 (264,000 acre feet) active capacity. Arrowrock Dam, a Reclamation project, is 19 rkm upstream of Lucky Peak Dam on the mainstem Boise River and discharges water into the Lucky Peak pool. Arrowrock dam has a full pool elevation of 980 meters above msl and $3.36x10^5$ km^3 (272,000 acre feet) active capacity. Anderson Ranch Dam, also a Reclamation project, is the most upstream and largest of the three water storage projects, located at rkm 81 of the South Fork of the Boise River. Anderson Ranch has a full pool elevation of 1,272 meters above msl and $5.09x10^5$ km^3 (423,000 acre feet) active capacity. These reservoirs are operated collectively to provide for irrigation, flood control, and recreation.

The Boise River basin upstream of Arrowrock Dam covers 5,700 km^2 of the granitic rock dominated landscape with elevations ranging from 931 m to 3231 m. The upper Boise River includes three sub basins: the North, Middle, and South Forks of the Boise River. The majority of the work discussed in this report occurred in Lucky Peak Reservoir on the mainstem Boise River (Figure 1). Lucky Peak Reservoir primarily stores water from the mainstem Boise River and from one small watershed, Mores Creek. The Boise River system is fed primarily by snowmelt run-off with highest flows occurring in April-May and lowest in September-October. Flows range from 11.33 m^3/s to over 198.28 m^3/s in the mainstem Boise River below the North and Middle Fork confluence. Land uses in the watersheds include grazing, recreation, and commercial and individual timber harvest. The majority of the Boise River basin lies within U. S. Forest Service with substantial area within designated Wilderness boundaries.

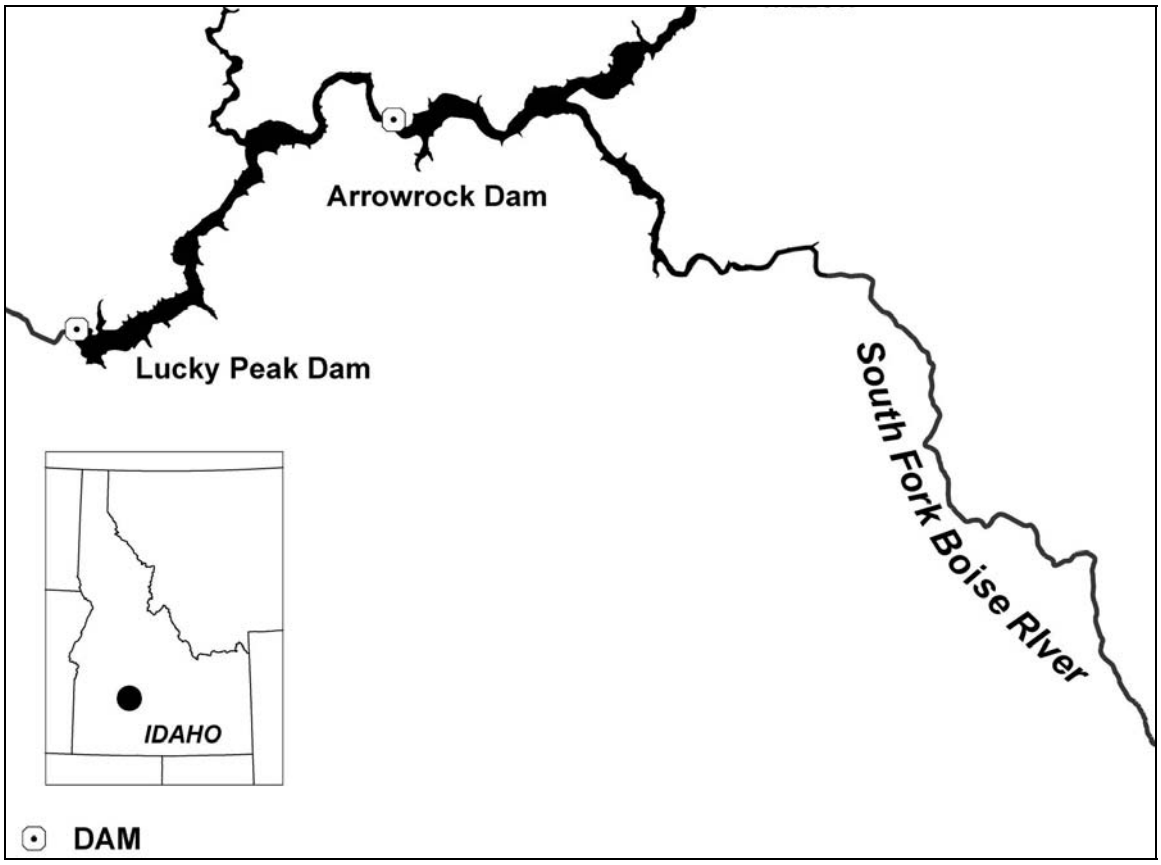


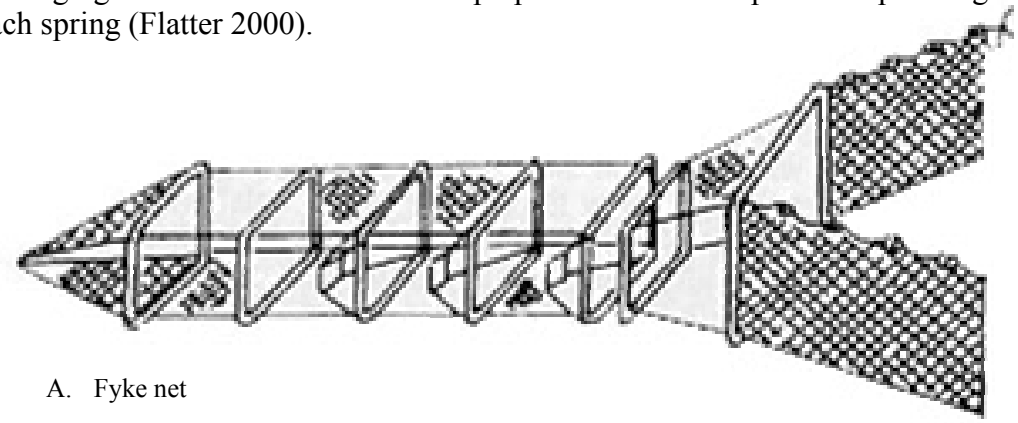
Figure 1. Lucky Peak and Arrowrock Reservoirs on the Boise River in Southwestern Idaho.

Methods

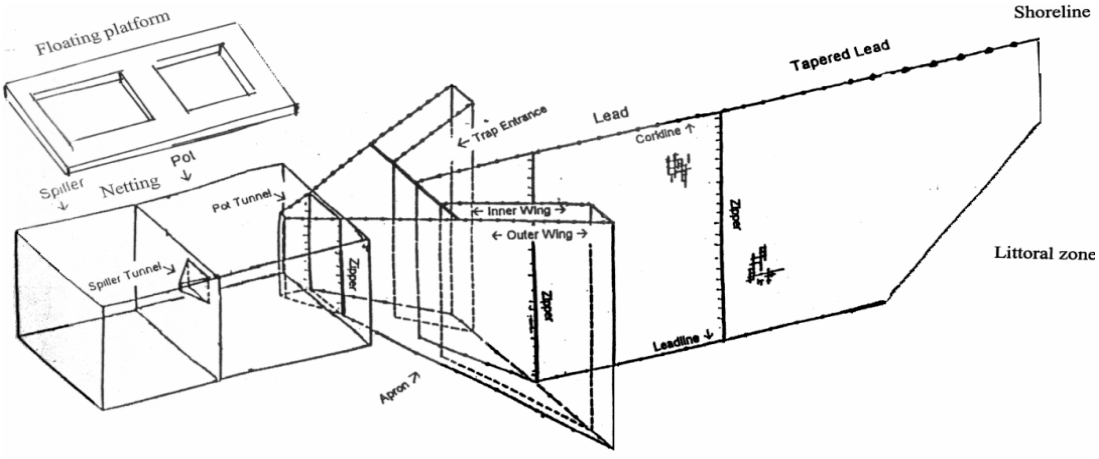
Fish Capture

We experimented with various methods of fish capture to determine the most successful method for catching bull trout in Lucky Peak Reservoir. Fish were collected using two different trap net designs and sinking monofilament gillnets from as early as March through late June each year, years 2000 through 2004. Trap nets consisted of sinking 1.22 m x 1.22 m x 0.91 m fyke nets with 30.48 m x 1.22 m lead lines (Figure 2). Sinking fyke nets were treated with an algicide to prevent decay and had 4 fykes per net. A floating Merwin-style trap net was also used. The Merwin net had 2 fykes, each were 4.57 m x 3.66 m with a 15.24 m floating lead (Figure 2). All trap nets were set for 24-hour increments and catch rates were calculated by hour of netting. Experimental mesh, monofilament gillnets were also used to capture bull trout (Figure 2). Gillnets were set for 20 minute intervals during the daylight period from 8:00 to 18:00 hours four days per week. Nets were 30.5 m long x 1.25 m deep with four equal-length panels. Each panel had one of four mesh sizes: 3.18 cm, 5.04 cm, 6.35 cm, and 7.62 cm. The nets had lead core bottom lines that followed the bottom of the reservoir and foam core top lines to maintain the vertical orientation in the water. Each net had 8 kg weights to anchor the bottom line and 20 cm diameter buoys on the top line for marking location and retrieval. Catch rates for each species were calculated for hours that the nets were fished.

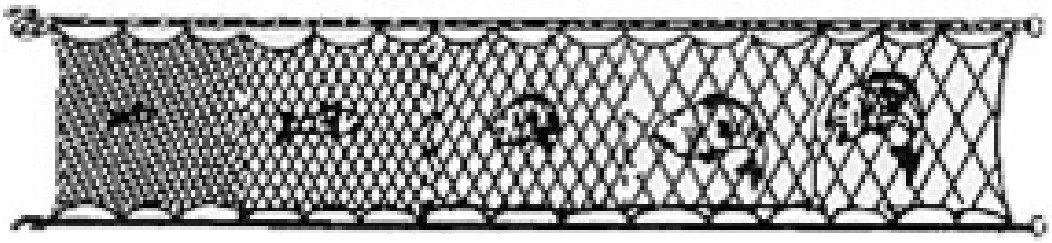
All captured bull trout were held in a 227 L live well of the boat with periodic water exchange until the end of each sampling day. The fish were then transported to Arrowrock reservoir, measured, tagged with PIT tags, and released. The seasonal period of trapping was chosen to increase efficiency of capture as bull trout were anticipated to be staging below Arrowrock dam in preparation for the upstream spawning migration each spring (Flatter 2000).



A. Fyke net



B. Merwin trap



C. Experimental monofilament gillnet

Figure 2. Illustrations of various trapping apparati for bull trout in Lucky Peak Reservoir

Fish Tagging and Handling

All fish captured were identified to species and enumerated. Total length (TL) was recorded for all game species. Bull trout were anesthetized using diluted tricaine methanesulfonate (MS-222) (approximately 100 mg/L). When a fish was considered anesthetized (could not right itself) it was measured and weighed. Scale samples and fin clips were taken, and the fish was scanned for Passive Integrated Transponder (PIT) tags (AVID computer corporation, Norco, CA 1999). All bull trout captured that were > 100 mm were tagged with 2.5 mm x 14 mm, 125 kHz PIT tags in accordance with instruction from Idaho Department of Fish and Game personnel (Russ Kiefer, IDFG, pers. comm.). Bull trout were held and monitored in live wells until full recovery (minimum 15 minutes), and then released into Arrowrock Reservoir. If surface water temperatures in Arrowrock Reservoir exceeded 18 C (65 F), bull trout were driven by boat to the areas of cooler water near river transistion zones in the reservoir. All recaptured bull trout were measured and weighed so that data for growth over the time period for mark and recapture could be recorded. Visible infirmity or injuries such as descaling, frayed fins, or dermal lacerations were noted.

Temperature and Elevation Measurements

Two methods were used to collect and verify temperature readings in the field. Surface water temperature was collected periodically throughout the day using the Bottomline Sidefinder™ Tournament leader 3200 (Meridian, Idaho) fish finder/condition monitor. In addition, air temperature was recorded every 2 hours at the Arrowrock dam Hydromet station. Hydromet station data was used for daily-accumulated precipitation, mean daily inflow and discharge, reservoir elevation, reservoir volume, and air temperature (Reclamation 2004).

Data Analyses

Environmental conditions such as surface water temperature, reservoir elevation, and Arrowrock dam discharge were documented with total catch per day and analyzed using multiple regression to investigate the relationship between reservoir conditions and fish capture.

Results

Fish Capture

A total of 6883 fish, representing eleven species, were captured with all three methods during the five years of the project (Table 1). Over 68% of all fish were captured using gillnets; however, this method also logged the greatest effort in hours. Fyke and Merwin traps were used as an experimental effort in 2001 and 2002. Though fyke nets had low rates of capture, the Merwin trap captured 2304 fish in < 400 hours of fishing with over twice the catch per unit effort of gillnets.

Table 1. Catch data listed for each species and by each method for all years

Species	**Merwin Net Fish Collection**		**Fyke Net Fish Collection**		**Gillnet fish collection**									
					2000		**2001**		**2002**		**2003**		**2004**	
	CPUE (mean)	7.47	CPUE (mean)	0.04	CPUE	3.70	CPUE	4.18	CPUE	4.42	CPUE	3.52	CPUE	4.11
	Total Fish	2155	Total Fish	6	Total Fish	1204.00	Total Fish	1844.00	Total Fish	956.00	Total Fish	545.00	Total Fish	1286.00
	Total Hours	288.5	Total Hours	144	Total Hours	325.38	Total Hours	440.90	Total Hours	191.04	Total Hours	154.65	Total Hours	312.60
	Number Caught	*CPUE*	*Number Caught*	*CPUE*	*Number Caught*	*CPUE*	*Number Caught*	*CPUE*	*Number Caught*	*CPUE*	*Number Caught*	*CPUE*	*Number Caught*	*CPUE*
Bull trout (*Salvelinus confluentus*)	0	0	0	0	26	0.08	24	0.05	3	0.02	10	0.06	22	0.07
Cutthroat trout (*Oncorhynchus clarki lewisi*)	1	0	0	0	7	0.02	25	0.06	8	0.04	5	0.03	10	0.03
Largescale sucker (*Catostomus macrocheilus*)	137	0.47	5	0.03	815	2.50	132	0.30	568	2.97	363	2.35	577	1.85
Rainbow trout (*Oncorhynchus mykiss*)	17	0.06	1	0.01	37	0.11	54	0.12	23	0.12	20	0.13	304	0.97
Northern Pikeminnow (*Ptychocheilus oregonensis*)	1811	6.28	0	0	218	0.67	280	0.64	151	0.79	67	0.43	77	0.25
Mountain whitefish (*Prosopium williamsoni*)	2	0.01	0	0	26	0.08	81	0.18	21	0.11	20	0.13	277	0.89
Chiselmouth (*Acrocheilus alutaceus*)	68	0.24	0	0	42	0.13	12	0.03	22	0.12	7	0.05	5	0.02
Bridgelip sucker (*Catostomus columbianus*)	118	0.41	0	0	24	0.07	25	0.06	145	0.76	43	0.28	35	0.11
Smallmouth bass (*Micropterus dolomieui*)	0	0	0	0	7	0.02	21	0.05	6	0.03	9	0.06	58	0.19
Kokanee (*Oncorhynchus nerka kennerlyi*)	0	0	0	0	2	0.01	2	0.00	4	0.02	1	0.01	1	0.00
Brown Bullhead (*Amieurus nebulosus)*	1	0	0	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Gillnetting Effort

A total of 4722 fish representing ten species were captured in 1425 hours of gillnetting (Table 1). Gillnetting was used as the primary method of capture based on previous work in the Boise River system (Flatter 2000). Eighty five bull trout were captured, which represented 1.8 percent of the total fish captured. They were not, however, the least abundant species sampled (Figure 3). Smaller numbers of fish species captured included ten kokanee (*O. nerka kennerlyi),* 101 smallmouth bass *(M. dolomieui)*, and 56 cutthroat trout *(O. clarki lewisi)*. The most abundant fish captured was the largescale sucker (*C. macrocheilus*), comprising 52 percent of all fish captured (Figure 3). Also noteworthy were northern pikeminnow (*Ptychocheilus oregonensis)*, comprising 17 percent of the total fish captured. Bridgelip sucker (*Catostomus columbianus)* total catch and catch per unit effort increased substantially in 2002, which may be due to several factors. Identification improved for this species of fish in 2002 and overall, more of them may have been captured.

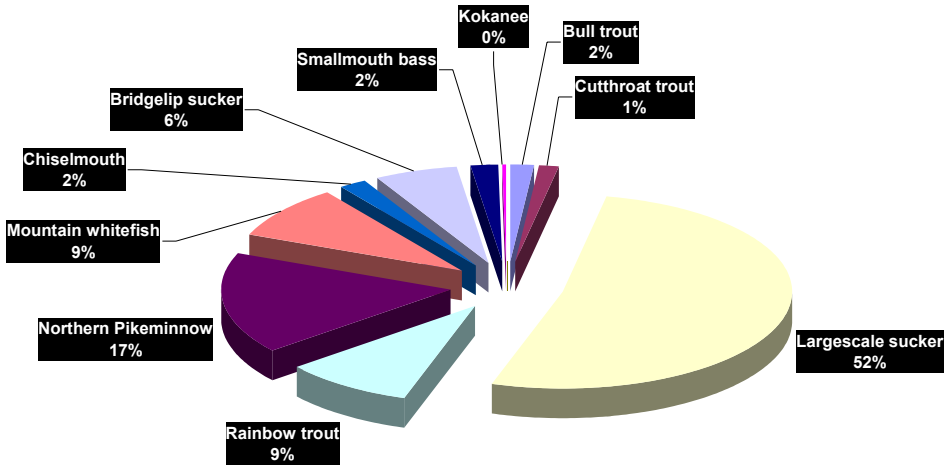


Figure 3. Species composition of gill net sampling in Lucky Peak Reservoir, 2000-2004

Catch per unit effort for bull trout decreased annually for the first three years though we increased our sampling hours in 2001 to incorporate a longer season (Figure 4). We significantly reduced our sampling effort in 2003 in anticipation of the valve replacement project at Arrowrock Dam. Our effort was increased to compensate for increased entrainment that occurred in 2004 due to the construction project. Catch per unit effort was significantly higher for bull trout

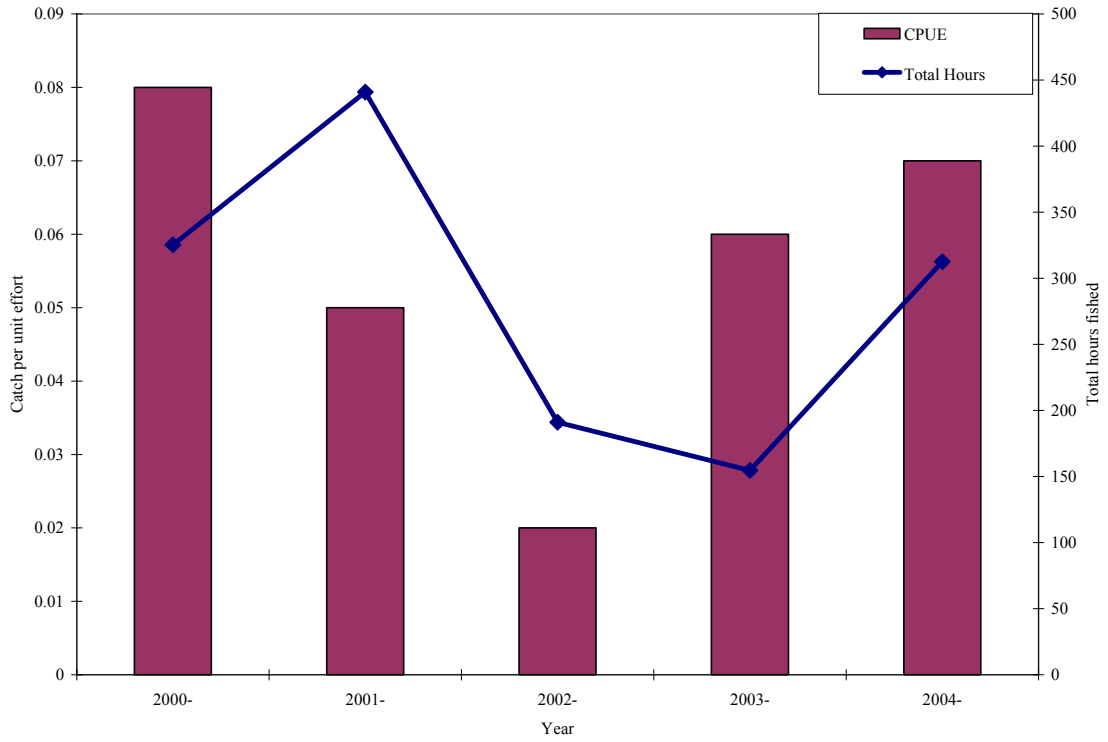


Figure 4. Catch per unit effort of gill net sampling for bull trout and hours sampled

Merwin Trapping Effort

A total of 2155 fish representing eight species were captured in the Merwin trap in 2002, the first year of operation (Table 3). No bull trout were captured with the Merwin trap. There are two possible explanations for no capture of bull trout at the Merwin trap (see Discussion). The trap was most successful in capturing northern pikeminnow, which comprised 84.03 percent of the total fish captured (Figure 5). High mortality rates occurred in the Merwin trap for small fish, being consumed by larger fish or descaled as they were impinged against the nets while being pursued by larger fish. It is recommended that cover be provided for small fish in this style of trap (see Discussion). This trap had the highest average catch per unit effort of all the trapping methods applied, 7.47 fish per hour fished. Additionally the Merwin trap required little staff time to operate compared to short gill net sets.

Table 2. Total number of fish captured with the Merwin trap and calculated catch per unit effort.

Species	Number Caught	CPUE
Bull trout (*Salvelinus confluentus*)	0	0.000
Cutthroat trout (Oncorhynchus clarki lewisi)	1	0.003
Largescale sucker (*Catostomus macrocheilus)*	137	0.475
Rainbow trout (*Oncorhynchus mykiss*)	17	0.059
Northern pikeminnow (*Ptychocheilus oregonensis*)	1811	6.277
Mountain whitefish (*Prosopium williamsoni*)	2	0.007
Chiselmouth (*Acrocheilus alutaceus*)	68	0.236
Bridgelip sucker (*Catostomus columbianus*)	118	0.409
Brown Bullhead (*Amieurus nebulosus*)	1	0.003
Total Fish	**2155**	
Total Hours	**288.5**	

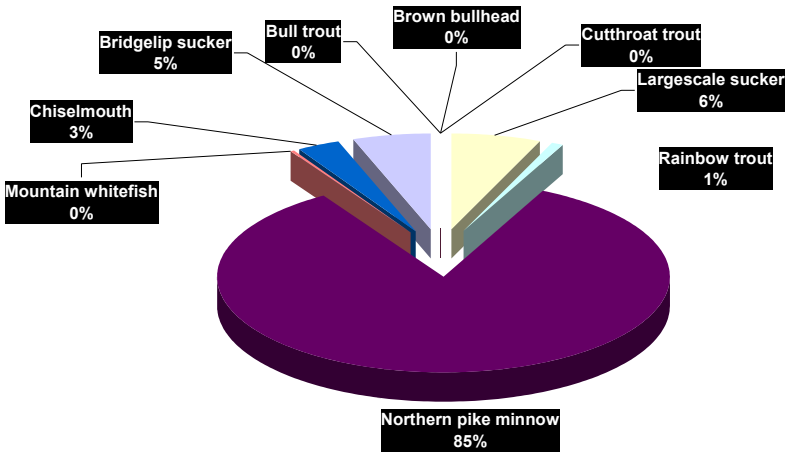


Figure 5. Species composition for Merwin trap catches in Lucky Peak Reservoir.

Fyke Net Trapping Effort

Two Fyke nets were operated in Lucky Peak Reservoir approximately 1.0 km downstream from Arrowrock Dam in the littoral region of the reservoir. Nets were run in overnight sets for a total of 144 hours. Only six fish were captured, 5 largescale sucker and one redside shiner. Several hypotheses may explain the poor rates of fish capture in fyke nets (see Discussion).

Fish Tagging and Handling

A total of 86 bull trout were captured in three years of the project ranging from 255 mm to 660 mm in total length and 198 g to 5402 g in weight (Figure 6). Seventy-seven of the bull trout were tagged with PIT tags. Two fish were transported to the Idaho Department of Fish and Game Nature Center and placed in the alpine lake area for public viewing. The remaining seven bull trout were not tagged due to obvious injury or mortality.

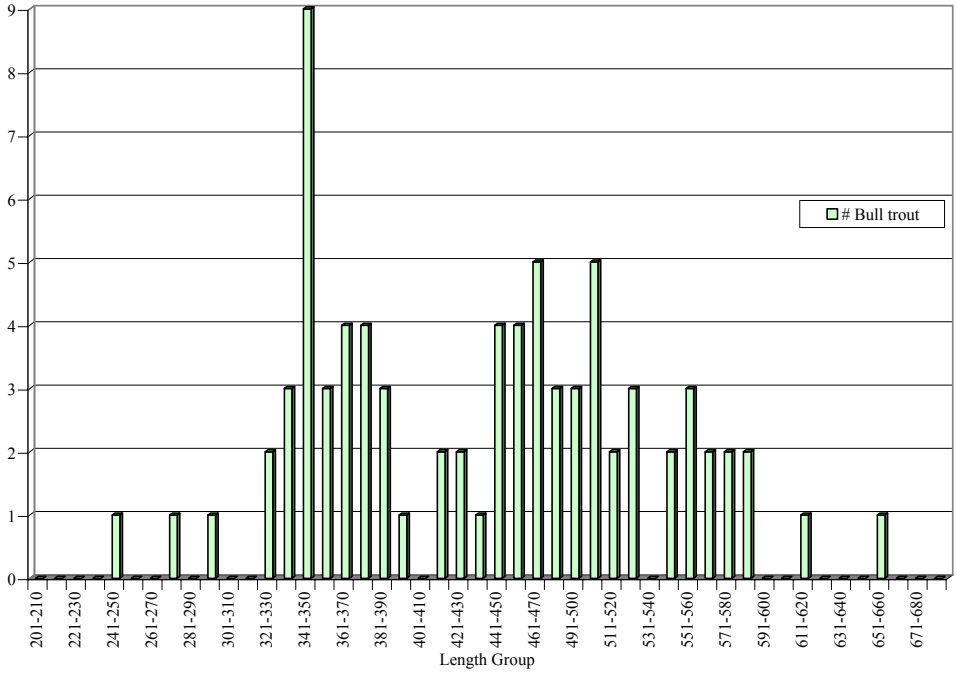


Figure 6. Length-frequency histogram of bull trout captured in years 2000-2002 in Lucky Peak Reservoir.

Temperature and Reservoir Elevation Related to Fish Capture

Surface water temperature data was collected consistently only during year 2002. However, air temperature collected at Arrowrock dam generally reflected the surface water temperature data collected in 2002. Additionally, surface water temperature fluctuated greatly within the water currents of the reservoir immediately downstream of Arrowrock dam as Lucky Peak Reservoir warmed and stratified. Surface water temperatures could be found to vary from 9 ˚C to 22 ˚C in less than one reservoir kilometer in later May and June in the area from Macks Creek boat ramp to Arrowrock dam (Figure 7). The variation in temperature was most likely the result of the deep release of water from the valves at Arrowrock dam and uneven mixing with the strata in Lucky Peak reservoir. Bull trout were captured primarily in one area of the reservoir (Figure 6), just downstream of Arrowrock dam, where surface water temperatures ranged from 9 ˚C to 15 ˚C

Total fish captured per day varied with daily temperature fluctuations and increased overall as temperatures increased (Figure 8). Little trend in total fish capture

was observed in relationship to reservoir elevations and discharge. A weak relationship existed between total fish captured and air temperature and elevation ($r^2 = 0.072$, $p < 0.05$) when data was grouped and analyzed over the all years of work. No significant relationship existed for bull trout collection when tested with the environmental variables collected. Most bull trout were collected in late May and early June. There are several possible explanations for the trend in bull trout capture rates (see Discussion).

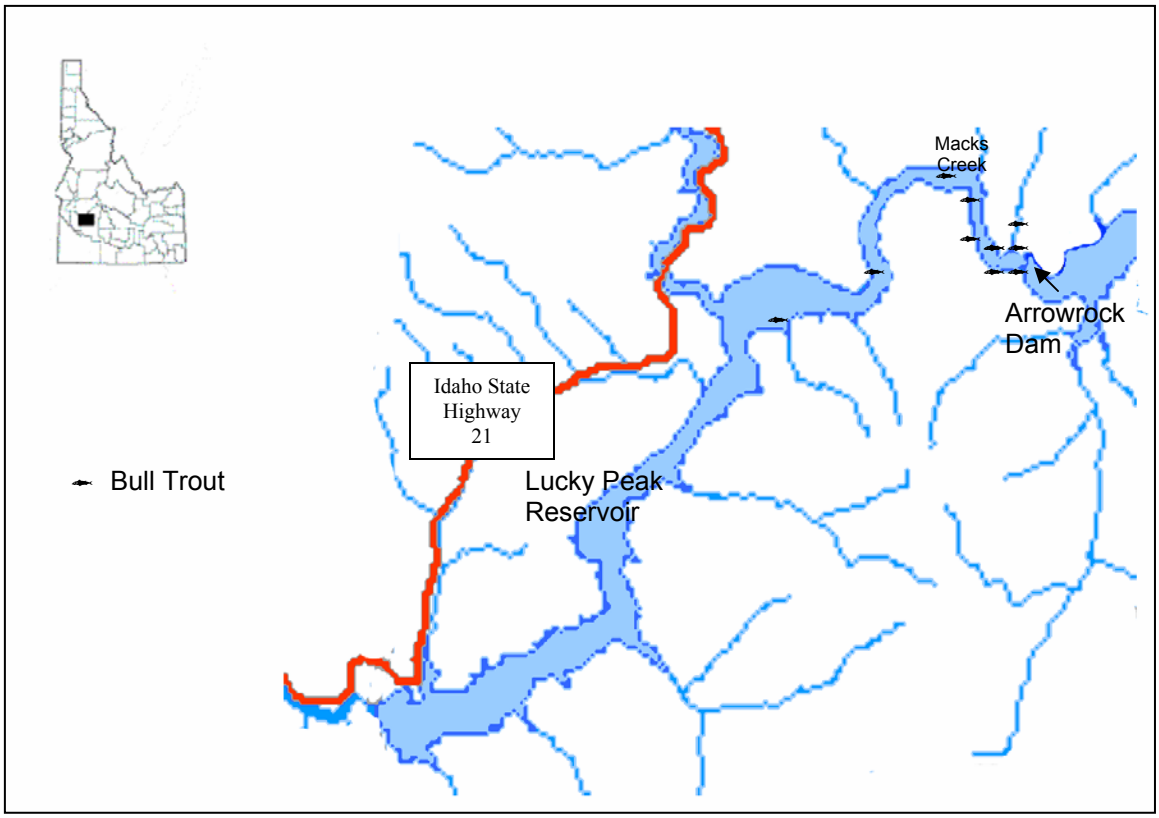


Figure 7. Lucky Peak Reservoir, general locations of captured bull trout in years 2000-2004.

Discussion

Overall fish capture was related to air temperature and reservoir elevation; however both of these conditions are influenced by time of year and discharge from Arrowrock Dam. Bull trout capture rates increased substantially in late May and early June in all years and most of these fish were captured at the downstream section of the spilling basin of Arrowrock Dam. Though we did not model temperature and the mixing zones during the trap and haul project, field crews did note thermal changes throughout the day and across the reservoir using the surface temperature recorder on the fish finder. One condition to note is that the time frame when the bull trout capture rates increased corresponded with the time frame when both Lucky Peak Reservoir and Arrowrock Reservoir begin to thermally stratify. These observations suggest an additional hypothesis about the underlying reasons for high bull trout capture rates in May and June

in the spilling basin below Arrowrock Dam. Water in the spilling basin below Arrowrock Dam does not begin mixing with Lucky Peak strata until it enters the constricted section downstream of the spilling basin (Figure 8). Temperatures are therefore significantly lower in the spilling basin (ranging from 9 C to 15 C as opposed to 17 C to 21 C in the mixing zone and upper strata) possibly providing thermal refugia to bull trout that may be staging to begin their spawning migration. Additionally, the rock outcropping and dredge pilings where the fish hold (Figure 9) may provide refugia from the higher flows that are near the outlet works of the dam.

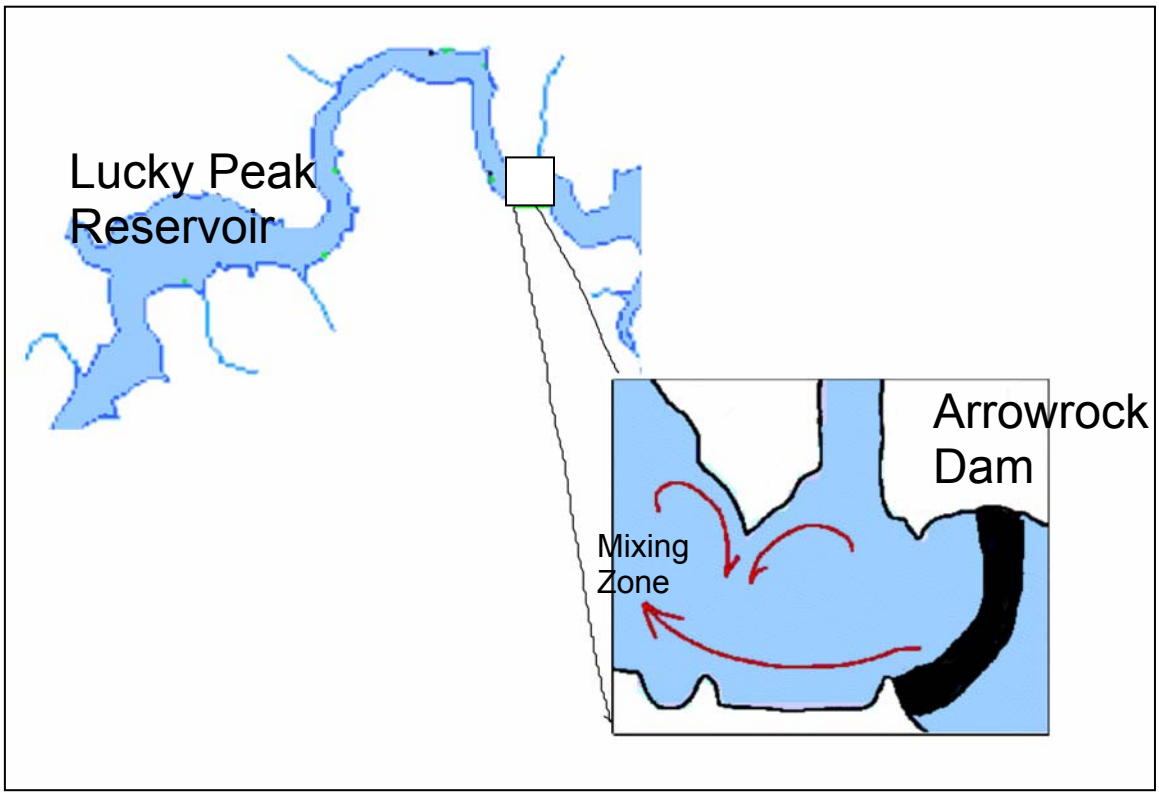


Figure 8. Direction of water currents in the Arrowrock Dam spilling basin and the mixing zone of the dam water discharge.

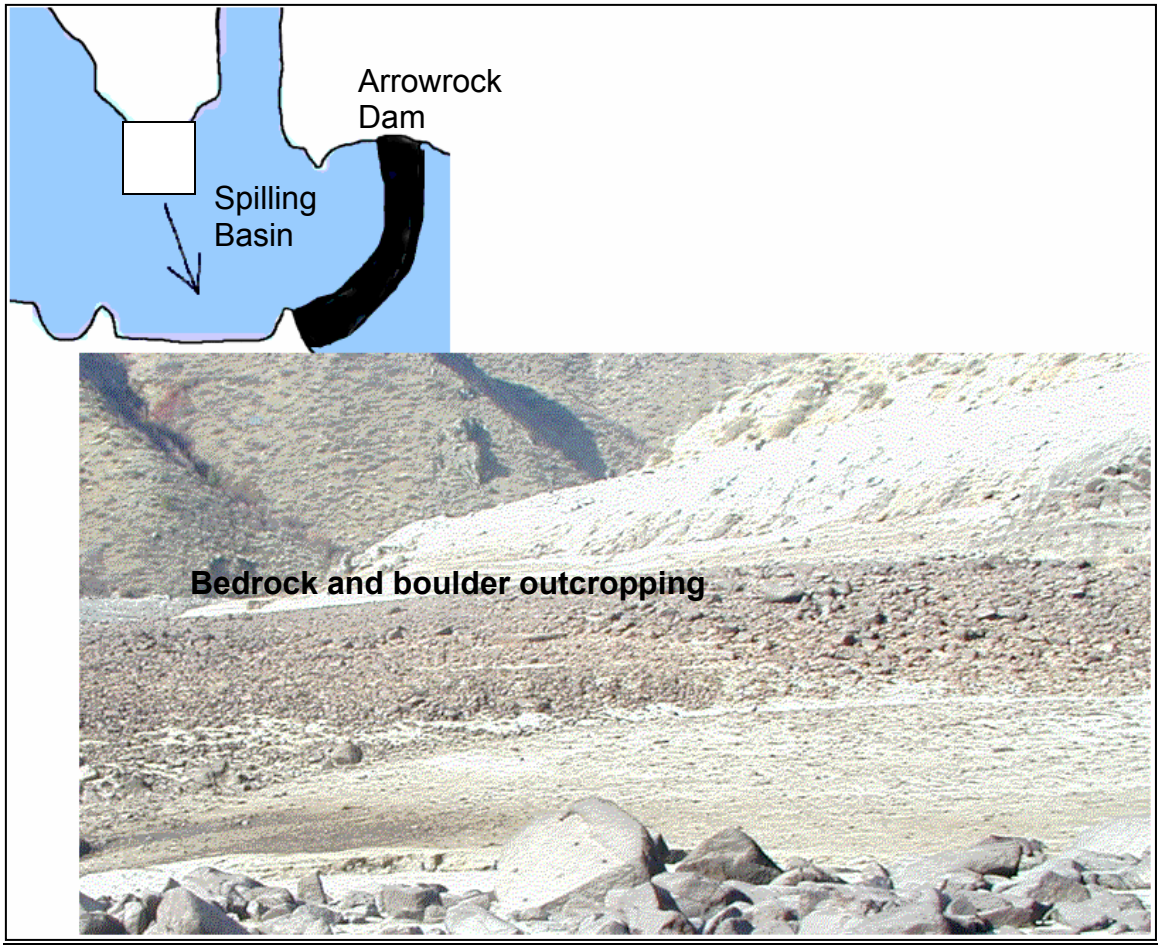


Figure 9. View of dewatered substrate area where most bull trout are captured in Lucky Peak Reservoir during the trap and transport project.

Gillnetting Results

Gillnets were the only method effective in capturing bull trout in Lucky Peak Reservoir. However, gillnets also can be injurious to bull trout and other fish species. Injury was reduced with gillnets by using short net-set times of 20 minutes, although some complications did occur with the times when nets were snagged on substrate materials. The reduction in bull trout capture rates during the first three years may reflect reduced entrainment levels due to reduced surface releases from Arrowrock dam as proposed by Flatter 2000. Salow and Hostettler (2004) document increased rates of entrainment from Arrowrock Dam during the construction period. Entrainment increased with increasing discharge from the dam when the Arrowrock Reservoir pool elevation was within 30 m of the outlet works. Our increased catch rates of bull trout in 2004 support the increased entrainment rates observed at the dam.

Merwin Trap Results

The Merwin trap was not successful in capturing bull trout, although it did capture a large number of fish in a short time. Several possible explanations exist for this occurrence. First, the trap is stationary and cannot be set where water current is present in the reservoir. Bull trout captured throughout the project in Lucky Peak Reservoir have been captured in close proximity to Arrowrock dam, where the water temperatures are the coldest and where water current can be quite strong. The Merwin trap was extremely effective in capturing fish, and if set in proximity to the spilling basin, could be effective in capture of bull trout. Second, only three bull trout were captured during the trap and haul effort in 2002. This may indicate lower densities of bull trout compared to other fish species in Lucky Peak Reservior. Additional support for this hypothesis comes from the fact that the mean catch per unit effort for gillnetting increased over the three years while the bull trout catch per unit effort decreased. There was substantial injury to fish observed in the Merwin trap, especially to smaller fish by the larger northern pike minnow. Injuries could be reduced by placing protective fish boxes in the spiller (Figure 2-B) and placing nets over the pot and stiller on the platform. The trap also became an attraction for predatory waterfowl because it concentrated fish in a small area and provided easy predation. Netting over the pot and stiller would prevent predation by birds on the fish.

Fyke Net Results

Fyke net capture rates for all fish species were very low. There are several explanations for the low capture rates encountered. First, Lucky Peak Reservoir is located in a relatively steep canyon, with few low gradient littoral regions available in which to set sinking nets. Second, the fyke nets were operated in the later part of April before water temperatures and fish activity increased. Fyke nets were relatively easy to operate and require little staff time other then to set and check them. We recommended that they be used as an experimental method of capture again in appropriate areas, later in the year after water temperatures increased and the reservoir has filled.

Recommendations

The most effective measure for capturing bull trout was using gillnets in the spilling basin from mid-May to mid-June. Gillnets require a large staff effort to both operate and maintain or repair, and have a lower total fish catch per unit effort. Therefore, recommendations include operating a Merwin trap in proximity to or within the spilling basin in conjunction with short-term gillnet sets. The time frame of sampling must include mid-May to mid-June to be most effective in capturing bull trout in Lucky Peak Reservoir.

Lucky Peak was drafted to > 1% active pool capacity in the fall of 2002 for repair work on Lucky Peak dam. In addition, Reclamation drafted Arrowrock reservoir to a similar capacity in the fall of 2003 and had a large sample of radio tagged bull trout that were monitored. Entrainment rates through Arrowrock Dam were documented to be significantly higher during the construction period (Salow and Hostettler 2004). Since the replacement of the Ensign valves allows higher discharge at a deeper depth in the water column, entrainment rates would be expected to decrease through time at Arrowrck Dam. Entrainment rates following the construction project need to be documented. If a

low number of bull trout are documented to become entrained, a trap and haul program is anticipated to be inefficient and not cost effective.

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